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CRREL

Establishment and Persistence of Cool- and Warm-Season Grasses on Sandy Soils

Antonio J. Palazzo

November 1994

Abstract

This study investigated the establishment and early persistence of warm- and cool-season grasses sown on sandy soils in a cool, humid climate. Two studies, conducted with several cool-season fine fescue species (*Festuca* sp.) and the warm-season species Blackwell switchgrass (*Panicum virgatum* L.) and little bluestem (*Andropogon scoparius* Michx.), also looked at straw mulch as an aid for early establishment. The results show that the two warm-season grasses and the cool-season fine fescue types have different growth habits, but all species are suitable for reducing erosion on coarse-textured soils containing more than 90% sand. The fine fescues established more quickly and produced a greater vegetative soil cover than little bluestem; they persisted for up to 3 years after seeding. Switchgrass, a warm-season grass, was taller and produced greater yields than the cool-season types. The straw mulch aided the establishment of the cool-season grasses. Both types of grasses are appropriate for revegetating sandy soils in a cool, humid climate.

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PREFACE

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Establishment and Persistence of Cool- and Warm-Season Grasses on Sandy Soils

ANTONIO J. PALAZZO

INTRODUCTION

Sandy soil areas, plentiful throughout the cool, humid areas of the United States consist of large land areas along highways (Wakefield et al. 1974), sand and gravel borrow sites (USDA-SCS 1980), mined lands (Paone et al. 1978) and Army training lands (Diersing et al. 1988). About 81,000 ha of sand and borrow areas exist in Pennsylvania, New York and New England (USDA-SCS 1980). On U.S. Army lands, revegetation of sandy soil has been identified as a problem at military installations in New York, Massachusetts and Wisconsin. Military sites differ from the other areas cited above in that the vegetation is degraded by the training mission (Shaw and Diersing 1990). These areas receive few or no applications of fertilizer and other soil amendments, so plants must be rapidly established to reduce soil erosion and return the lands to training as quickly as possible (Diersing et al. 1988).

Sandy soils are difficult to vegetate because of their low moisture and nutrient holding capacities. Adding finer textured soils or organic amendments will improve plant establishment success, but it is expensive and not always practical. It is more cost-effective to locate plants that are adaptable to these environments.

Warm-season grasses appear to be the species of choice to revegetate low-use areas of sandy, infertile soils. They were initially promoted by agriculturists during the Dust Bowl years of the 1930s for reseeding abandoned farmlands, severely eroded sites, droughty soils, rangelands, and other areas where common cultivated grasses often fail (Schwendiman and Hawk 1975). Gaffney and Dickerson (1987) reported that warm-season grasses were the best grass species to use for a long-term, low-maintenance vegetative cover in sandy and gravelly soils containing less than 15% fine soil (clay plus silt textured soils). Morris et al. (1982) reported that warm-season grasses grown on a shaly silt loam soil had greater yields than cool-season grasses during the second year after planting. Both Morris et al. (1982) and Wuenscher and Gerloff (1971) attributed the better growth of warm-season grasses over cool-season types to their greater tolerance of and adaptation to lower levels of available phosphorus in soils.

A disadvantage of warm-season grasses is their slow and inconsistent establishment rate and a limited seeding season (Bryan et al. 1984, Panciera and Jung 1984). This is a major obstacle to their use at sites that need rapid revegetation. Bryan et al. (1984) reported that their slow establishment rate made these species sensitive to competition from existing vegetation and weeds. Morris et al. (1982) reported that the cool-season grasses were more productive in their first year than were warm-season grasses. Warm-season grasses also produce greater quantities of dry matter, which accumulates and creates a fire hazard.

The fine fescues (*Festuca* sp.) are a group of fine-leafed grass types and include the species chewings (*F. rubra* L. subsp. *commutata* Gaud.), hard (*F. longifolia* Thuill.), red (*F. rubra* L.), and sheeps (*F. ovina* (L.) Koch.). They have been reported to be tolerant of droughty soils, but have been only briefly studied in this type of environment. Palazzo (1993) reported that Jamestown chewings fescue and Canada bluegrass (*Poa compressa* L.) were the two most persistent species of 11 cool-season grasses tested on well-drained fill materials. Bradshaw and Chadwick (1980) recommended red fescues for revegetating sand heaps in England. Wakefield et al. (1974) reported on the long-term persistence of fine fescues grown on roadside subsoils. However, very little information is available on the growth of these species in soils containing greater than 90% sand and less

than 10% fine materials, although Gaffney and Dickerson (1987) stated that sheeps fescue was the best performer of six cool-season grasses tested on gravel mine sites.

The objective of this work was to investigate the rate of establishment and early persistence of warm- and cool-season grasses sown on sandy soils as affected by seeding time and mulch.

MATERIALS AND METHODS

Experiments were conducted from 1987 through 1992 at the Fort Drum military facility in northern New York. The two sites were located on a Plainfield sandy soil that contained 90% sand (Table 1). As mentioned, all experiments compared the establishment and subsequent growth of warm- and cool-season grasses.

Table 1. Soil textural characteristics (%).

Location no.	*Sand*	*Silt*	*Clay*
1	90	8	2
2	91	7	2

Location 1

Here, cool- and warm-season grasses were sown and mulched in May 1987. The soils had an initial pH of 6.5 and contained 12 and 62 kg/ha of P and K respectively. The site was prepared by rototilling to 15-cm depth and fertilizing at the rate of 660 kg/ha of a 10-10-10 grade fertilizer.

The experiment was designed to have a split-plot with three replications, providing 24 individual research plots measuring 4 m on a side. Two main plots were mulched at rates of 0 and 2240 kg/ha; the subplots were sown with the cool-season grasses Jamestown chewings fescue (CF) and common hard fescue (HF) and the warm-season grasses common little bluestem (LB) and Blackwell switchgrass (SG). The cool-season grasses were sown at the rate of 180 kg/ha and warm season grasses at 135 kg/ha. After being seeded, the soil site was hand-raked to a depth of 2 cm.

The percentage of plant cover was measured on 22 September 1987, 19 July 1988 and 18 August 1989. Biomass data were recorded on 20 October 1987 and 19 July 1988 by clipping a 1-m^2 area of plant tissue at a 2.5-cm height. An ANOVA was used to determine significant differences between treatments and the LSD test was used to separate the means.

Location 2

A this site, the soil had an initial pH of 5.5 and contained 20 and 8 kg/ha of available P_2O_5 and K_2O respectively.

The study was designed as a random complete block, consisting of four species (Jasper creeping red fescue [CRF], Jamestown CF, SG and LB) and three straw mulch rates (0, 2240 and 4480 kg/ha). Also sown, but only in the unmulched plots, were Koket and Victory CF. There were 64 individual research plots measuring 5 m on a side. The site was prepared on 9 May 1989 by rototilling to a 15-cm depth and fertilizing at a rate of 660 kg/ha with a 10-10-10 grade fertilizer. On 8 May 1990 and 24 April 1991, the plots were treated with 10-10-10 grade fertilizer at a rate of 670 kg/ha. Basagran herbicide (EPA Reg. #7969-45) was applied to the research plots at the recommended rate with a back- pack sprayer to control the invasion of sedge (*Carex sp.* and *Cyperus sp.*) in May 1990. On 23 June 1992 plant heights and mean vegetative soil cover were measured at two random locations on each plot with a 10-point frame sampler described by Hayes et al. (1981). An area of 4 m^2 in each plot was harvested by cutting the vegetation to a height of 8 cm with a sickle bar. Clippings were weighed and a subsample dried to constant weight for dry weight determination.

The data were analyzed two ways. First, as a split-plot design, including the four species with the three mulch rates, and second, as a one-way ANOVA test, containing all six species sown without a mulch cover. The LSD test was used to separate means.

Soil temperatures were measured in 1992 with a system used by Culik et al. (1982) at a specially prepared site adjacent to the plots to compare the surface temperatures of bare and straw-mulched soils. Copper-constantan thermocouples attached to nonshielding cable were used. The temperatures were measured hourly for 115 days, between 16 May and 5 September 1992 and the weekly means were recorded with an Omni-data temperature recorder. A paired *t*-test was used to determine differences in soil surface temperature between the bare and mulched soils.

RESULTS

Location 1

Significant differences for leaf weights and plant ratings for soil cover were found among species in 1987, 1988 and 1989 (Table 2). The species × mulch interactions were also significant, but the effect of

mulch did not cause a difference in any of the plant yield data collected during the 3 years.

Switchgrass sown without a mulch cover had the greatest yields in 1988 and 1989 (Table 3 and Fig. 1). There were no differences in leaf weights for the other species and mulch rates. Soil cover ratings in September 1987 (4 months after seeding) showed that SG without mulch had the highest mean soil cover ratings, and in 1988 it was followed by CF with mulch (Fig. 2). In 1988, SG without a mulch cover and the two fine fescues with mulch had the highest soil cover ratings. In 1989, SG without mulch continued to have the greatest soil cover of any of the treatments, followed by HF with mulch. When sown without mulch, little bluestem had a lower soil cover rating than SG. Soil cover ratings were greater in 1987 and 1988 when a mulch was spread with the CF and HF seeds. In 1989 the effect of the mulch was no longer present.

Table 2. *F* Values at location 1 for dry weight and soil cover ratings.

Parameter	*Leaf weights*		*Soil cover ratings*		
	1988	*1989*	*1987*	*1988*	*1989*
Mulch (M)	1.25	6.71	0.28	0.72	11.52
Species (S)	12.31**	4.96**	19.41**	2.54	5.86**
M × S	0.04**	5.34**	6.31**	11.31**	4.30*

* Significant at 5% level.
** Significant at 10% level.

Table 3. Plant yields and cover ratings at location 1 in 1989.

Species	*Mulch*	*Leaf weight (g/m^2)*		*Soil cover ratings (%)*		
		1988	*1989*	*1987*	*1988*	*1989*
CF	No	3.5	4.5	20	37	23
CF	Yes	5.3	5.7	33	63	27
HF	No	4.5	7.5	8	33	63
HF	Yes	4.3	8.7	17	53	65
LB	No	3.4	14.7	8	43	27
LB	Yes	3.6	4.9	2	25	32
SG	No	8.9	40.0	47	85	77
SG	Yes	5.2	6.2	25	27	18
LSD 0.05		1.9	15	12	25	32

Location 2

At location 2, one experiment examined four species (SG, LB, Jasper CRF and Jamestown CF) and three mulch rates, and another six species (the four above species and Koket and Victory CF) without mulch. Significant differences in plant biomass were found only among species.

In the study without mulch, significant differences among species were found for plant heights and weight, but not for mean vegetative soil cover (Table 4). Heights ranged from 24 to 39 cm, with SG being

Figure 1. Switchgrass growing on a sandy soil.

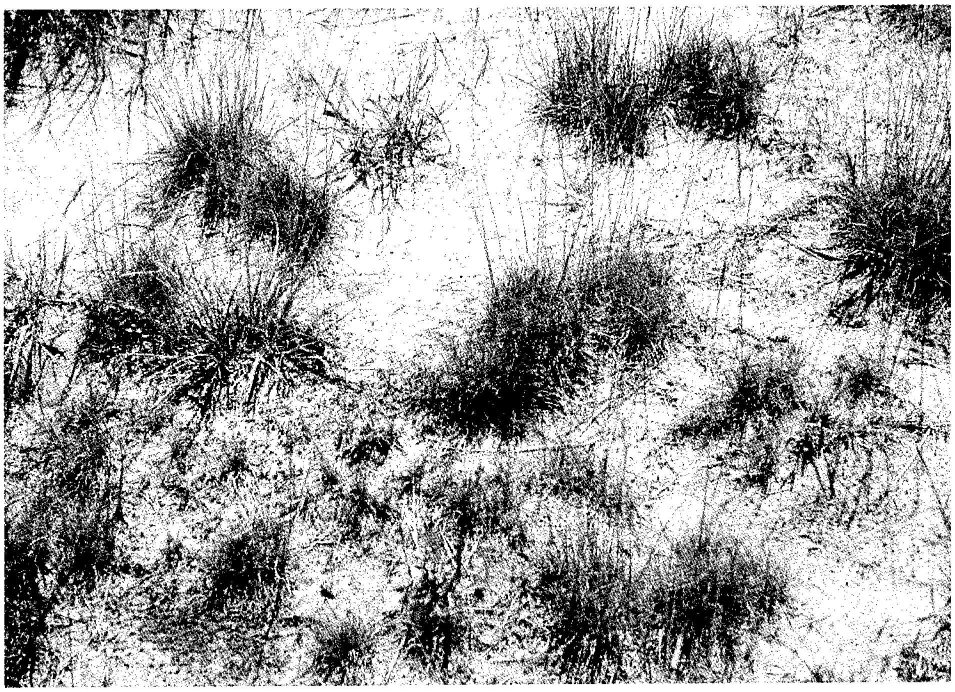

Figure 2. Chewings fescue growing on a sandy soil.

Table 4. Plant biomass yields of species sown in spring at location 2 in 1992 or three years after seeding.

Plant	*Soil cover (no. aerial hits)*	*Plant height (cm)*	*Harvest dry weight (g)*
Warm season			
L. bluestem	5	30	701
Switchgrass	6	39	816
Cool season			
Jasper CRF	6	24	245
Jamestown CF	8	25	208
Koket CF	7	28	422
Victory CF	8	30	514
F Value	3.00	6.33*	12.32*
LSD 0.05	Not significant	7	218

* Significant at the 5% level.

tallest. The two warm-season grasses produced more biomass then any of the four cool-season grasses tested. Seedhead production differences were also observed among the fine fescues: Victory and Koket CFs produced more seedheads than did Jamestown CF or Jasper CRF. This factor may have implications in the ability of these bunch grasses to spread in future years.

Spring and summer soil surface temperatures for the bare and straw-mulched soils recorded in 1992 are shown in Figure 3. The mean soil surface temperatures were greater on no-mulch plots, as expected. Weekly temperature differences ranged from 0.8 to 7.0°C higher on the bare soil plots, with the greatest variation in the spring. Throughout the spring and summer, the bare soil temperature mean was 4.0°C higher than that on the mulched soil surface.

DISCUSSION

The two studies show that the two warm-season grasses and the cool-season fine fescue types are all suitable species for controlling erosion on sandy soils. The most appropriate species to incorporate into seed mixtures depends on the site and future use of that land. The fine fescues established just as rapidly as the SG and faster than LB. If the land is to be used for Army training exercises, the down-time needed for reseeding and plant establishment will be shortened with the use of species that establish themselves quickly. The use of cool-season species could help shorten the time required to re-establish adequate vegetation on sites that are slated to sustain traffic, since they can be sown in both spring and fall, and their establishment reliability is more consistent (Panciera and Jung 1984).

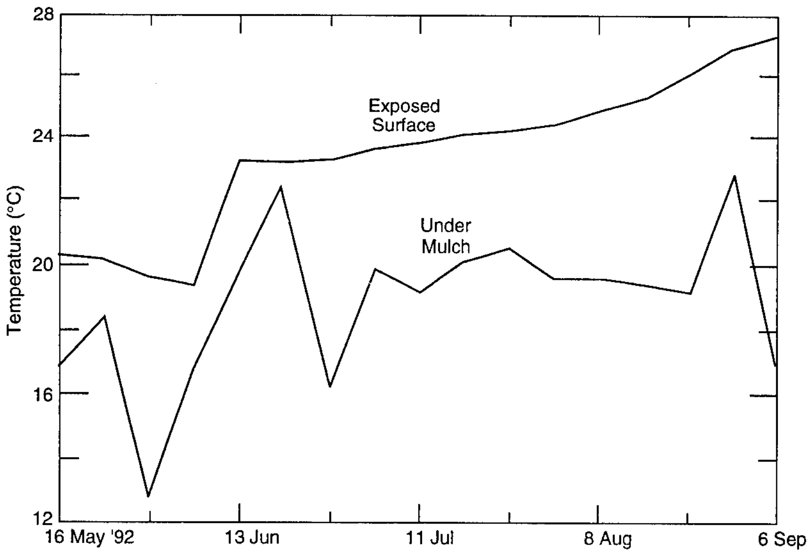

Figure 3. Soil temperature at surface of bare soil and below mulch layer.

The greater biomass yields of the warm-season grasses 2 years after seeding are caused by their physical characteristics, which include coarse leaves and stems of taller plants. Morris et al. (1982) found the biomass produced by warm-season grasses to be up to three times greater than that of cool-season grasses during the second year of growth.

The various grasses had different growth habits. The cool-season grasses produced similar or greater vegetative soil cover, and therefore had similar erosion control value. The warm-season grasses were taller and produced greater yields.

The water requirements of both types are different, but both are adaptable to the low moisture-holding capacity of sandy soils. Watschke and Schmidt (1992) reported that the warm-season grasses have deeper root systems and can tolerate drought better than most cool-season types. However, Biran et al. (1981) reported that warm-season grasses consume more water, owing to their vertical growth habit, than do cool-season grasses, which have a low, compact growth habit.

Another finding here was the contrasting difference in establishment with the use of mulch to modify soil surface temperature and moisture. In the two experiments that looked at multiple mulch rates, one showed no significant effect in its use with either cool- or warm-season species, while the other showed the mulch to promote the establishment of the cool-season grasses and hinder the yields of the warm-season species. Without the use of a mulch, the soil seedbed temperature was an average of 4°C higher than the mulched soil. DiPaola and Beard (1992), in a review of temperature stress on turfgrass growth, reported that the most optimum root growth of cool-season grasses occurs between 10 and 18°C, while for warm-season grasses it occurs between 24 and 29°C. Dickerson et al. (1988) reported that warm-season grasses grew more vigorously on the warmer south-facing slopes than on the cooler north-facing ones in a cold climate (northern Vermont). This warm environmental requirement for the establishment of warm-season grasses could be the reason why mulches did not promote seed germination for them.

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13. ABSTRACT (*Maximum 200 words*)

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